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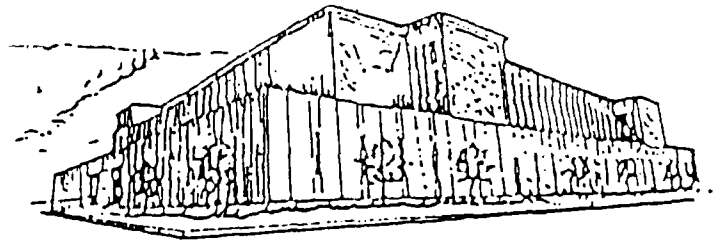

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WELLHEAD PROTECTION PLANNING:
A COMPARISON OF TWO COMMUNITIES' APPROACHES
MISSOULA, MONTANA AND POLSON, MONTANA

By

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B.A., Colgate University, 1985

Presented in partial fulfillment of the requirements

for the degree of

Master of Science

University of Montana

1994

Approved by:

Chairman, Board of Examiners

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Wilson, Karen J., M.S. December 1994 Environmental Studies

Wellhead Protection Planning: A Comparison of Two Communities' Approaches, Missoula, Montana and Polson, Montana

Director: Dr. Vicki Watson VW

The purpose of this paper is to review and critique the first complete wellhead protection (WHP) plans prepared in Montana. Two communities will be used as case studies to demonstrate the strengths and weaknesses of different approaches. The paper will describe successful and unsuccessful methods used in the Missoula and Polson wellhead protection plans and offer recommendations for other communities interested in pursuing wellhead protection.

The Wellhead Protection Program is a federal program, established by the Safe Drinking Water Act Amendments of 1986, that requires states and communities to prepare groundwater protection plans for public water supply wells. The State of Montana did not begin developing a statewide Wellhead Protection Program until 1990. In 1993, the Montana Department of Health and Environmental Sciences submitted the Draft Montana Wellhead Protection Plan (1992) to the United States Environmental Protection Agency (EPA) for review and approval. The document has undergone several revisions, but has not yet been approved by the EPA.

Two Montana communities, Missoula and Polson, forged ahead and developed wellhead protection plans for their public water supply wells with little guidance from the state. Both communities depended upon information available from EPA and other communities nationwide to guide the development of their wellhead protection plans. The two wellhead protection plans reflect the differences in the communities that they address. Missoula is a large Montana city with numerous commercial and industrial businesses and associated threats of groundwater contamination. In fact , two Missoula municipal wells have been taken off line because of groundwater contamination. The Missoula WHP Plan focussed on reducing existing potential contamination threats to groundwater.

Polson is a smaller city with a limited commercial and industrial sector. In Polson private septic systems and underground storage tanks pose the greatest threat to the groundwater. The Polson WHP Plan focussed on preventing the siting of future potential contamination sources within the wellhead protection area.

Communities can use both the Missoula and Polson WHP plans as good examples of Montana wellhead protection plans.

ACKNOWLEDGEMENTS

Research for this project was conducted while I was employed at the Missoula City-County Health Department and Shannon Environmental Services. I would like to thank the following individuals and organizations for their support during the graduate school experience: Deb Moravec; Jon Shannon and everyone at Shannon Environmental Services; Vicki Watson, Tom Roy and Sandie McQuillan of the Environmental Studies Program; Bill Woessner of the Geology Department; Paddy Trusler, Lake County Land Services; John Campbell, Polson Water Department; Carole Mackin, MDHES; Jim Carlson and the people at the Missoula City-County Health Department; Arvid Hiller, Mountain Water Company; and Ray Lazuk, Hydrometrics, Inc.

Thanks also goes to my parents for always encouraging me to conquer new challenges. Mom, I wish you could see that I finally did finish this.

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1.0 INTRODUCTION

This paper will review and evaluate the first complete wellhead protection plans prepared in Montana. It will describe successful and unsuccessful methods used in the Missoula and Polson wellhead protection plans and offer recommendations for other communities interested in pursuing wellhead protection.

1.1 History of Groundwater Protection in Montana

Groundwater is a natural resource that people became increasingly aware of during the 1970's and 1980's. Approximately half of all Americans and 95 percent of rural Americans depend upon groundwater for drinking water (EPA, 1990 A.) Groundwater is also vital to agriculture and industry. Research conducted on the quality of groundwater in the 1970's and 1980's by state and federal agencies revealed significant areas of contamination in portions of the United States. These findings led to more research and ultimately the development of programs to protect groundwater. The Wellhead Protection Program is one of the new programs created to protect groundwater.

Wellhead Protection is a federal program, established by the Safe Drinking Water Act Amendments of 1986, that requires states and communities to prepare groundwater protection plans for public water supply wells. The United States Environmental Protection Agency (EPA) recommends that wellhead protection plans consist of the following seven elements: 1) project management; 2) wellhead protection area delineation; 3) contamination source inventory; 4) management alternatives for contamination sources; 5) wellhead

protection for future wells; 6) contingency planning; and 7) public participation.

The Wellhead Protection (WHP) Program is a unique federal program because its focus is on prevention of groundwater contamination, not remediation of contaminated areas. It is also unusual because it promotes groundwater protection at the local level. Each state designs its own Wellhead Protection Program using EPA guidelines. Once the state has established minimum Program requirements, communities and water suppliers are required to prepare Wellhead Protection Plans for their public water supply wells.

Although the Wellhead Protection Program was established in 1986, funding to states did not become available until 1989. Montana did not begin wellhead protection activities until 1990. The Wellhead Protection Program is not a complete groundwater protection program. Wellhead Protection only addresses the protection of recharge areas to public water supply wells. It does not attempt to protect recharge areas to domestic wells or groundwater in general.

Over half the states now have EPA approved wellhead protection programs. The Montana Department of Health Environmental Sciences (MDHES) submitted a first draft of the Montana Wellhead Protection Program (1992) to the EPA in 1993. EPA reviewed the Montana Program and recommended numerous changes. Several additional drafts have since been submitted to the EPA. None have yet been approved (Carole Mackin, personal communication, 1994.)

The creation of the Wellhead Protection Program reflects a growing

concern for groundwater protection that began in earnest in Montana in the early 1980's. In 1982 the Bureau of Mines and Geology published a report on the occurrence and characteristics of groundwater in Montana and the Governor appointed the Groundwater Advisory Council to evaluate Montana's groundwater policies and programs. That same year, the Environmental Quality Council (EQC), working with the Water Resources Oversight Committee and the Montana Water Resources Research Center, held a Montana groundwater conference in Great Falls (Mackin, 1991.)

While federal and state officials began to develop wellhead protection programs, local water suppliers and governments in Montana were becoming more involved in groundwater protection efforts. For example, in 1988 Missoula County petitioned the Environmental Protection Agency to designate the Missoula Aquifer as a Sole Source Aquifer (Missoula City-County Health Department, 1988.) Approval of that petition paved the way for further groundwater protection activities in Missoula and likely helped the City-County Health Department attain EPA funds for an underground injection well survey.

The year 1989 marked the beginning of multiple agency involvement in groundwater protection at the state level. The Montana Legislature passed Senate Joint Resolution 22 that directed the EQC to study the protection and management of groundwater (Mackin, 1991.) This process involved establishing a Groundwater Data Task Force. Results of these studies were published in two reports in 1989, *Ground Water Quality Protection and Management* and *Proposed Montana Ground Water Monitoring and Information*

Plan. The Legislature also directed the Department of Agriculture and the Department of Health and Environmental Sciences to implement the Montana Agricultural Chemical Ground Water Protection Act. The Montana Cooperative Extension Service at Montana State University published a multipage folder of information designed to inform the public about rural and urban domestic, industrial and agricultural surface and groundwater issues (Mackin, 1991.)

State and local governments continued to increase their involvement in groundwater issues in 1990. The Montana Bureau of Mines and Geology established the Ground Water Information Center to conduct studies, compile statistics and publish reports concerning Montana geology and hydrogeology. Missoula County and Mountain Water Company completed several reports addressing well contamination and began to develop a local wellhead protection plan. The City of Sheridan passed the first ordinance in Montana protecting groundwater resources. The ordinance requires any "offensive and unwholesome establishment" that threatens to pollute the groundwater supply or anyone who handles "potentially polluting material" within a three mile radius of the City to obtain a permit. The Sheridan ordinance also includes an enforcement component. The City of Polson also took steps to protect their groundwater supply by applying for a Department of Natural Resources and Conservation Renewable Resource Development Grant to fund the preparation of a wellhead protection plan for the City.

The 1991 Montana Legislature passed two acts addressing groundwater protection. The Montana Groundwater Assessment Act established a

Groundwater Assessment Steering Committee and provided for the characterization and monitoring of certain groundwater areas each year. The Local Water Quality District Act authorized county commissions to create local water quality districts. These districts provide counties with a mechanism to implement ground and surface water quality protection programs. Also in 1991, Mountain Water Company issued a draft Wellhead Protection Plan for their public water supply wells in Missoula.

In 1992 and early 1993 Lewis and Clark and Missoula Counties implemented local water quality district programs. Lewis and Clark County established the first local water quality district in January of 1992 when the County passed Resolution 1992-16, "A Resolution of Intention to Create a Water Quality Protection District in Lewis and Clark County." The Missoula program, entitled the "Missoula Valley Water Quality District," was proposed by the Missoula Board of Commissioners, the City of Missoula and the Missoula City-County Health Department. The program was unveiled to the public late in 1992 and approved by the County Commissioners in early 1993.

As of February, 1994, only three communities in Montana have attempted to prepare complete wellhead protection plans. Mountain Water Company and the Missoula City-County Health Department (MCCHD) initiated the first Montana wellhead protection plan in 1990. The Missoula Wellhead Protection Plan was issued in final form in 1992. The City of Polson Water Department and Lake County Land Services began their wellhead protection efforts in 1990. The Polson Wellhead Protection Plan was issued in draft form in July,

1993. A final document was issued in February, 1994. The City of Choteau started wellhead protection activities in September, 1993. Because they were not very far along in the wellhead process, they were not featured in this paper.

Missoula and Polson were able to develop complete wellhead protection plans largely because they obtained significant funding from sources outside of local government. Missoula was the first, and thus far, largest community to attempt wellhead protection. The funding for the Missoula Plan came from several sources including: Mountain Water Company, the MCCHD, and the EPA. The Polson Plan was funded primarily with grant money from the Montana Department of Natural Resources and Conservation. The Polson Water Department and Lake County Land Services also contributed in kind services to the development of the Plan.

1.2 The Missoula and Polson Wellhead Protection Plans

The primary motivation for development of both the Missoula and Polson WHP Plans was protection of the drinking water obtained from groundwater. Missoula is 100% dependent upon groundwater as a drinking water source and Polson relies upon a combination of surface water and groundwater for drinking water supply. Although the motivation and goals of both projects were similar, the Missoula and Polson Wellhead Protection Plans are very different. The size of community, kind of water purveyor, degree of available information, and sources of funding were all factors in the communities developing such different Plans. Each of these factors will be discussed in detail in the next few chapters. The recommendation portion of the following chapters will highlight effective

methods of approaching each element based upon the experiences of Missoula and Polson.

The development of both the Missoula and Polson Wellhead Protection Plans was hindered due to the lack of a Montana Wellhead Protection Program. The MDHES did not begin development of a statewide WHP Program until 1990. Because the Montana WHP Program was being reviewed by the EPA and underwent several revisions, the Missoula WHP Plan and the Polson WHP Plan were developed with little guidance from the State. Fortunately, many other states and communities have implemented WHP programs and plans, which contain information valuable to communities launching wellhead protection plans.

2.0 ROLES AND RESPONSIBILITIES IN WELLHEAD PROTECTION

Generally local government agencies assume a leadership role in developing wellhead protection plans. In a community where the water purveyor is a private company, as in Missoula, the responsibilities associated with wellhead protection are split between government and private companies. The following paragraphs focus on the roles and responsibilities of organizations involved in the development and implementation of the Missoula WHP Plan and the Polson WHP Plan.

2.1 The Missoula Wellhead Protection Plan

Mountain Water Company (MWC) is the main water purveyor for urban Missoula. The Missoula Wellhead Protection Plan (MWHPP) states that 50,000 of the approximately 68,000 residents in Missoula are served by MWC (Hydrometrics, 1992.) Mountain Water Company uses 34 public water supply wells to supply water to its customers. The Missoula community historically used Rattlesnake Creek to supplement Mountain Water Company's 34 wells until 1983 when the organism *Giardia lamblia* was detected in drinking water obtained from the Creek. A cost analysis was conducted and Mountain Water Company decided to abandon the Rattlesnake Creek supply and depend solely upon groundwater as a drinking water source. Mountain Water Company has also detected contamination in its public water supply wells (Hydrometrics, 1992.) Two MWC production wells were indefinitely taken off line after traces of perchloroethene were detected in drinking water from the wells. One of

Mountain Water Company's largest producing wells, the Maurice Street Well, was temporarily shut down in 1990 when it was contaminated with bacteria from a nearby failed city sewer lift station. These water quality problems, along with the recognized vulnerability of the aquifer, were the primary motivation for the creation of the Missoula Wellhead Protection Plan (Hydrometrics, 1992.)

Mountain Water Company funded several elements of the Plan, and after it was developed, successfully requested a rate increase to cover some of the costs associated with the development of the Plan (Arvid Hiller, personal communication, 1993.) The Missoula City-County Health Department contributed significant amounts of employee time and effort to the project. The MCCHD received a non-WHP EPA grant to investigate underground injection wells in the Missoula valley. This grant enabled the MCCHD to locate and map one of the major potential sources of contamination in the Missoula valley.

Other organizations, including the Missoula Interagency Groundwater Task Force, assisted MWC and MCCHD with the development of the plan. However, MWC and MCCHD directed the development of the MWHPP. Mountain Water Company was responsible for project management and delineation of areas to be protected, with assistance from an environmental consulting firm, Hydrometrics. The MCCHD conducted the contamination source inventory. A "core" group, consisting of Hydrometrics, its subcontractors, Mountain Water Company, MCCHD, and other interested parties, shaped the general direction of the Missoula WHP Plan (Hydrometrics, 1992.)

The Missoula WHP Plan took approximately three years to prepare.

(Some management aspects are still being implemented, see Chapter 5.0.) The development of the Missoula WHP Plan greatly increased public awareness of groundwater protection in Missoula. In 1993, prior to completion of the MWHPP, Missoula County created the "Missoula Valley Water Quality District." The District enables the MCCHD to establish and enforce groundwater and surface water protection programs.

The primary responsibility for implementing the Missoula WHP Plan falls to the Missoula City-County Health Department. As a private company Mountain Water Company is limited to delivering potable drinking water to their customers. The MCCHD, along with State and Federal organizations, is responsible for enforcing any laws or regulations designed to protect groundwater (Hydrometrics, 1992.)

2.2 The Polson Wellhead Protection Plan

The Polson Wellhead Protection Plan (PWHPP) was initiated by the Polson Water Department and Lake County Land Services (Lake County's equivalent of the Missoula City-County Health Department.) The City of Polson relies upon three municipal wells to supplement drinking water attained from Hell Roaring Creek. The Polson Water Department (PWD) supplies drinking water to the City of Polson's approximately 3,200 residents (Shannon Environmental Services, 1994.) Hell Roaring Creek is currently the City's primary source of drinking water, however, a *Giardia lamblia* incident and changes in drinking water regulations have caused the City to consider depending upon groundwater as the primary source of drinking water. The City

of Polson applied to the Department of Natural Resources and Conservation for a Renewable Resources Grant to enable them to prepare a wellhead protection plan. The City hired Shannon Environmental Services, an environmental consulting firm, to prepare the Polson Wellhead Protection Plan.

Due to the size and location of the area the Polson Wellhead Protection Plan targeted for protection, four primary entities are responsible for administering environmental programs within the protected area--the City of Polson, Lake County, the Confederated Salish and Kootenai Tribes and the State of Montana. An Advisory Group consisting of members from the above mentioned entities and other interested parties was formed to oversee and guide development of the PWHP Plan. The Polson Water Department and Lake County Land Services were very involved in each element of the Plan, especially the contamination source inventory. Employees from the PWD and LCLS conducted a potential contamination source inventory of properties located within the wellhead protection area.

Once the project was started, the development of the Polson WHP Plan took approximately two years. Coincidently, the City of Polson and Lake County were completely revising the zoning regulations for the area within the City-County Planning Area at the same time the Polson WHP Plan was being developed. Zoning changes recommended in the Polson WHP Plan were incorporated into drafts of both the Polson Development Plan (1993) and Master Plan (1993.) Final drafts of the Polson Development Plan and Master Plan had not been completed when this paper was written. Chapter 5.0

describes the proposed zoning changes in more detail.

2.3 Recommendations for Roles and Responsibilities

The Missoula and Polson WHP projects had several factors in common that appeared to facilitate the development of wellhead protection plans. Clear roles and responsibilities were established in the early stages of both projects. The water purveyor in both communities was the primary motivator behind the preparation of the wellhead protection plan and played an active role in development of the plan. Both communities also formed multidisciplinary WHP Advisory Groups at the beginning of the project. This is one way to enable impacted constituents the opportunity to offer input into the development of WHP plans from the beginning of the project.

Funding is another important part of the development of a wellhead protection plan. Missoula and Polson were able to develop comprehensive wellhead protection plans largely because they obtained significant funding from sources outside of local government. Mountain Water Company has spent over $300,000 to develop and implement the Missoula WHP Plan (Arvid Hiller, personal communication, 1994.) This figure does not include the time and support that the MCCHD has contributed to the project. The Polson WHP Plan cost approximately $83,000 to develop and implement, approximately $76,000 came from a DNRC Renewable Resources Grant and the remainder from Polson and Lake County in-kind services (Paddy Trusler, personal communication, 1994.) Organizations interested in preparing wellhead protection plans should be aware that not all projects applying for Department

of Natural Resources Renewable Resources Grants receive approval for funding. And those projects that do receive funding usually receive it months to years after application.

Most communities cannot afford to spend these kinds of funds for the development and implementation of groundwater protection plans. Because of this, it is recommended that other Montana communities use the Missoula WHP Plan and the Polson WHP Plan as guides for the development of their own wellhead protection plans. Much of the work involved in preparing a WHP plan can be conducted by city and county employees using information contained in EPA documents and the Missoula and Polson WHP plans. The reference section of this paper lists several useful EPA publications. Communities may need to hire a hydrogeologist or other experienced groundwater professional to delineate areas to be protected. However, each of the other plan elements can be prepared by a team of local government employees.

Another potential source of outside funding is the United States Environmental Protection Agency. The EPA historically has had limited funds available for demonstration grants related to different aspects of wellhead protection planning. Over the past five years, each of the ten EPA regions has solicited proposals from communities for activities related to a defined aspect of wellhead protection. For example, in 1991, the City of Choteau, Montana was selected to receive an EPA Wellhead Protection Demonstration Grant that related to the development and implementation of a wellhead protection plan in a rural agricultural community. The EPA grant to Choteau totaled $25,000.00

and was one of four grants issued to the six state area comprising Region VIII of EPA. These grants are very competitive and relate to specific aspects of wellhead protection determined by the EPA. The future of this grant program is tenuous; it is approved by Congress on a yearly basis. Communities or individuals interested in finding out more information about the availability of EPA Wellhead Protection Demonstration Grants are encouraged to contact the EPA Region VIII office in Denver, Colorado, or the Montana Wellhead Protection Coordinator at the Montana Department of Health and Environmental Services. Appendix A includes addresses and telephone numbers for these organizations, as well as for others that participated in the Missoula and Polson Wellhead Protection Plans.

3.0 WELLHEAD PROTECTION AREA DELINEATION

The EPA describes a wellhead protection area as the surface and subsurface area surrounding a well or wellfield that supplies a public water system, through which contaminants are likely to pass and eventually reach the well or wellfield (EPA, 1987.) To help communities in developing wellhead protection plans, the EPA has determined five general methods for delineating wellhead protection areas. They include: arbitrary fixed radius; calculated fixed radius; simplified variable shapes; hydrogeologic mapping; analytical equations; and computer modeling (EPA, 1987.) The simple and variable shapes methods are the least sophisticated and easiest to apply. The next three methods require more detailed information about the aquifer being delineated. Because Missoula and Polson acquired outside funding for their WHP plans, both communities were able to use sophisticated methods of delineation. Polson used a combination of hydrogeologic mapping, analytical equations and simple computer modeling (Shannon Environmental Services, 1994) while Missoula used a sophisticated computer model (Hydrometrics, 1992.)

The first step in delineation involves locating existing information concerning the geology and hydrogeology of the study area and collecting new data if needed. The next step consists of selecting a method that uses the geologic and hydrogeologic data to delineate a "zone of contribution" to the public water supply wells. To create wellhead protection areas, communities modify the scientifically zones of contribution to consider political boundaries

and reasonable management areas.

Determining a zone of contribution (ZOC) to each well can be technically challenging. The zone of contribution is the area surrounding a pumping well that supplies groundwater recharge to the well (EPA, 1987.) Figure 1 shows a generalized zone of contribution for a pumping well. The extent of the zone of contribution in the upgradient direction can be determined in many ways. The EPA document, *Guidelines for Delineation of Wellhead Protection Areas*, 1987, explains several methods. Both Missoula and Polson decided to use "time of travel" as the method of measuring the upgradient direction. The "time of travel" method attempts to estimate the distance a particle of water would travel in a selected time period (365 days for example) as it moves towards a pumping well. This method provides an understandable method of presenting travel through the aquifer. Communities can use one year, five year, ten year, or any other, time of travel period.

The selection of time of travel for delineation of the upgradient limit of the zones of contribution was about the only thing that the Missoula and Polson delineation element had in common. Missoula and Polson approached the delineation element differently primarily because the extent of existing information concerning the aquifers was very different. Significant amounts of information on the Missoula aquifer enabled the Missoula WHP Plan to use a sophisticated computer modeling approach, while the paucity of data concerning the Polson aquifer limited the delineation choices.

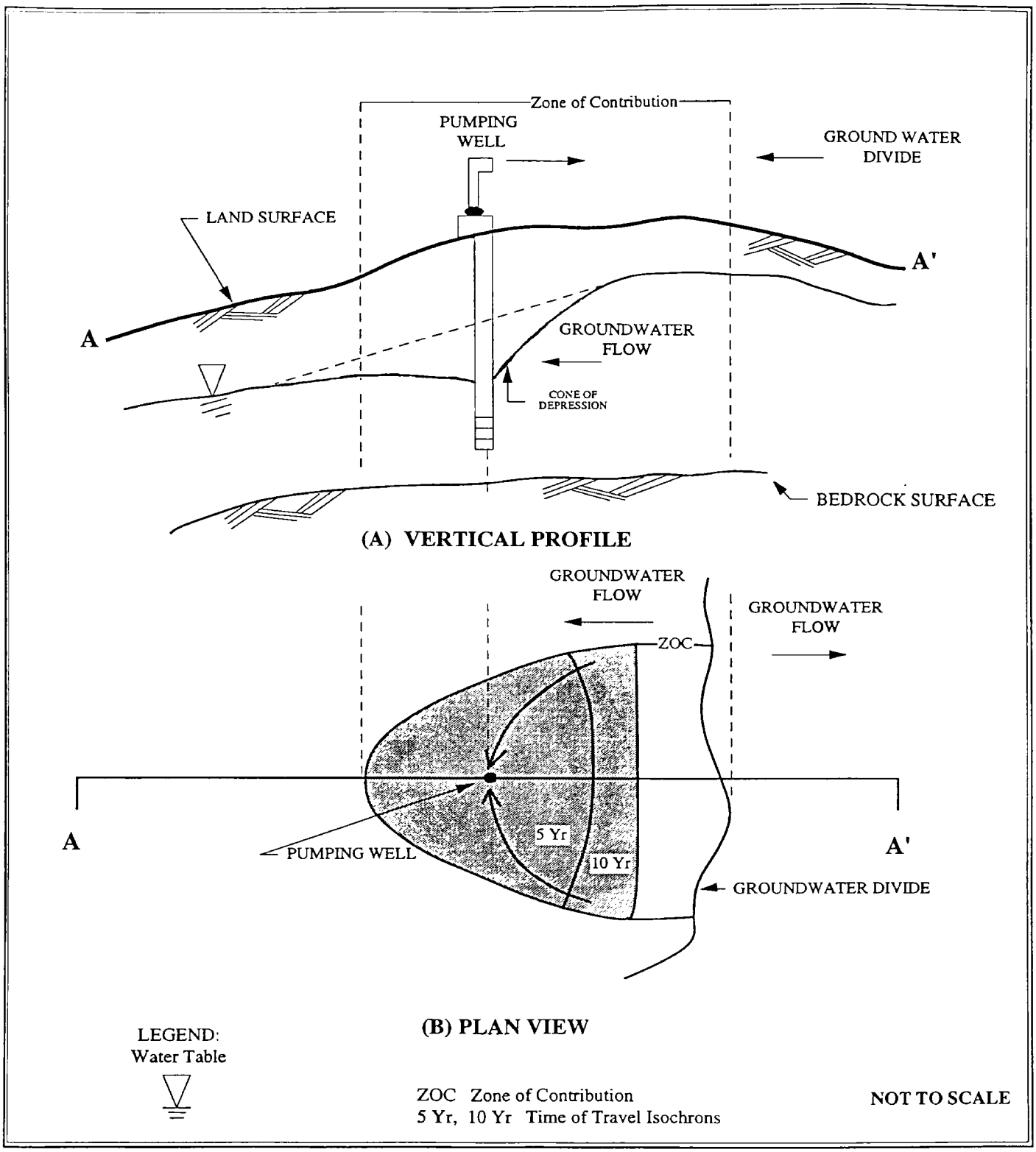

Figure 1 Generalized Zone of Contribution

Source: Shannon Environmental Services, 1994

3.1 The Missoula Wellhead Protection Plan

Various attributes of the Missoula Aquifer have been studied for the past fifteen years by numerous researchers. As a result, a significant database exists that characterizes the aquifer, and takes into account seasonal variations in groundwater recharge and flow. This background information enabled the writers of the Missoula plan to use an existing numerical computer model (Miller, 1990) to determine the zones of contribution to the 34 Mountain Water Company wells in Missoula (Hydrometrics, 1992.)

The Missoula aquifer is a highly transmissive unconfined system consisting primarily of coarse sand and gravel alluvium. The aquifer is overlain by approximately 50-75 feet of sand and gravel. The majority (over 90%) of recharge to the aquifer comes from the Clark Fork River, which loses water to the aquifer for the first few miles after it enters the Missoula Valley from the east at Hellgate Canyon (Hydrometrics, 1992.)

The zones of contribution for nearly all of the Mountain Water Company wells extend from the well upgradient to the Clark Fork River. Some of the 34 ZOCs overlap, and some extend for miles. Figure 2 shows the ZOCs for the MWC wells. In order to delineate manageable wellhead protection areas, the Missoula WHP Plan used a zoned approach. The goal of the zoned approach was to offer the areas closest to the wells the highest protection, and to limit the size of the most protected areas due to the stringent protection requirements (Hydrometrics, 1992.)

The three zones are identified in the Missoula Wellhead Protection Plan

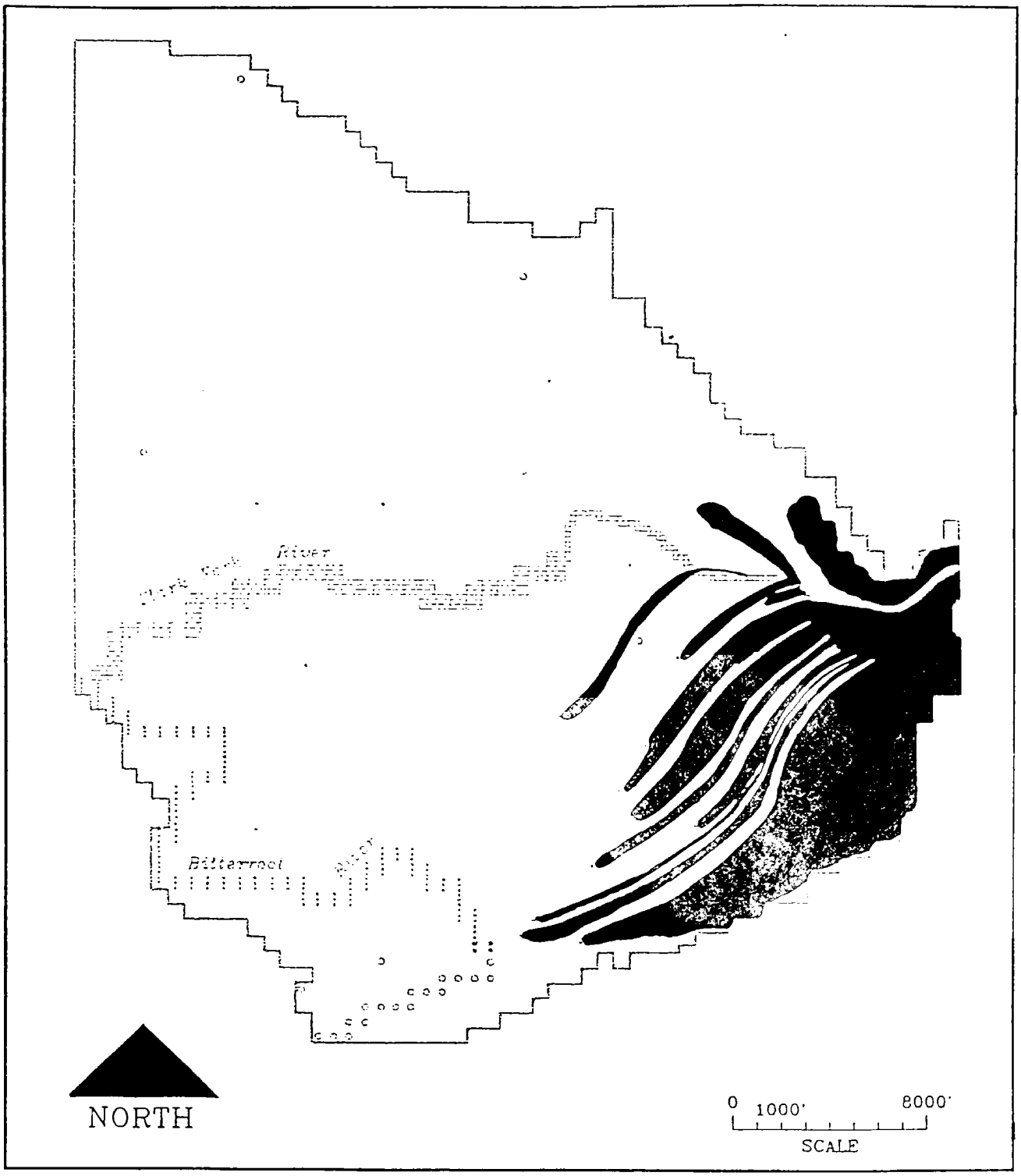

Figure 2 Missoula Zones of Contribution
Maximum Pumping Rates, Low Water Table
Source: Hydrometrics, 1992

(Hydrometrics, 1992) as:

Zone 1 Critical Wellhead Protection Area

This zone includes a portion of the zone of contribution immediately surrounding the wellhead, in addition to a small transition or buffer zone. The downgradient and lateral boundaries of Zone 1 roughly coincide with zone of contribution flow boundaries and include a 200 foot buffer zone. The upgradient boundary is located 1,000 feet in the upgradient groundwater flow direction. (The 1,000 foot buffer zone roughly coincides with the 30 day time of travel criterion.)

Zone 2 Primary Wellhead Protection Area

This zone consists of all zones of contribution to wells and includes a transition or buffer zone of several hundred feet.

Zone 3 - Peripheral Wellhead Protection Area

This zone consists of adjacent and upland areas which could contribute groundwater and surface water recharge to Zone 2.

The Missoula WHP Plan refers to Zone 1 as Critical because it is believed that a contaminant introduced into the aquifer within Zone 1 of a well would reach the wellhead in spite of an immediate remedial response (Hydrometrics, 1992.) Mountain Water Company could turn the well off and then mitigate the contaminant, however, that may not remediate the problem. Stringent management approaches in the Critical Zone are the best way to ensure protection of the wells.

The purpose of Zone 2, the Primary Zone, is to prevent aquifer contamination and/or mitigate any contamination that may occur and reach a wellhead. Zone 2 is managed for prevention, detection and remediation of potential contamination events at a level less stringent than Zone 1 (Hydrometrics, 1992.)

Zone 3, the Peripheral Zone, includes areas that likely contribute small quantities of water to Zone 2. The degree of land use management in this area is much less restrictive than Zones 1 or 2 (Hydrometrics, 1992.) A figure showing the Missoula WHPA and zones was not available in the Missoula WHP Plan.

The boundaries for Zones 1 and 2 were based on the computer model delineations and then modified slightly. Downgradient and lateral buffer zones were added to the delineated zones for additional protection. The Zone 2 boundaries were also modified to coincide with man-made and natural geographic features (Hydrometrics, 1992.)

3.2 The Polson Wellhead Protection Plan

The same quality and quantity of information was not available for the Polson aquifer. Two regional studies of groundwater on the Flathead Indian Reservation had been completed in the 1980's. In addition, some partial studies of the aquifer in the vicinity of two of the public water supply wells had been conducted. However, the aquifer parameters had not been fully characterized, and little information concerning seasonal groundwater fluctuations existed.

The geology and hydrogeology of the Polson aquifer are complex. The Polson Moraine, a recessional moraine, is a prominent feature south of Polson. Regional groundwater flow in the area is reported to flow from the south to the north, through the Moraine (Slagle, 1988.) Drillers' logs report sand, gravel and clay in the moraine deposits (Shannon Environmental Services, 1994.) Depths to groundwater in the moraine vary from 200 feet to over 600 feet according to driller's logs and a water level survey conducted by Shannon Environmental Services. In some parts of the Moraine well borings in excess of 700 feet have not encountered groundwater. The aquifer in the vicinity of the Moraine appears to be a semi-confined system (Shannon Environmental Services, 1994.) North of the Moraine the sand, gravel and clay lenses transition into massive clay with occasional sand seams. Groundwater north of the Moraine is much shallower, approximately 20 feet below land surface. The aquifer in this part of Polson appears to be a confined aquifer (Shannon Environmental Services, 1994.) The massive clay has much lower hydraulic conductivity than the gravel and sands and its presence creates a confined system.

A limited investigation of the aquifer was conducted during the development of the WHP plan in order to determine the zones of contribution. A pumping test and water level measurements were conducted to further determine the properties of transmissivity, hydraulic gradient and groundwater flow direction for the aquifer. The new information collected enabled the preparers of the Polson WHP plan to combine the use of a simple analytical computer model, analytical equations and hydrogeologic mapping to delineate

zones of contribution. The computer model used, WHPA Code, was developed by the EPA for community use in zone of contribution delineation (EPA, 1991 A.) The computer model was used to confirm analytical equation calculations and to produce estimates for ranges of parameter values (Shannon Environmental Services, 1994.) EPA has published a document entitled, A Modular Semi-Analytical Model for the Delineation of Wellhead Protection Areas Version 2.0 (1991 A) to accompany the computer model and explain appropriate applications of the model. Any community can contact EPA or MDHES to obtain a copy of the program (see Appendix A for addresses and phone numbers.)

The zones of contribution delineated for the Polson public water supply wells were divided into three "time of travel" areas: from 0 to one year, from one year to five years and from five years to ten years. Because the Polson zones of contribution were based upon limited information, Shannon Environmental recommended that the delineated zones of contribution be used as guides rather than finite ZOCs (Shannon Environmental Services, 1994.) Buffer zones that extended the ZOCs 15 degrees in each direction perpendicular to the direction of groundwater flow were added to the ZOCs. Figure 3 shows the zones of contribution and the 15 degree buffer zones for the Polson wells.

The Polson Wellhead Protection Advisory Group decided to include the area between the two zones of contribution in the wellhead protection area to be sure that all possible seasonal variations for the zones of contribution would be included in the wellhead protection area (Shannon Environmental Services, 1994.) The Advisory Group also decided to divide the wellhead protection area

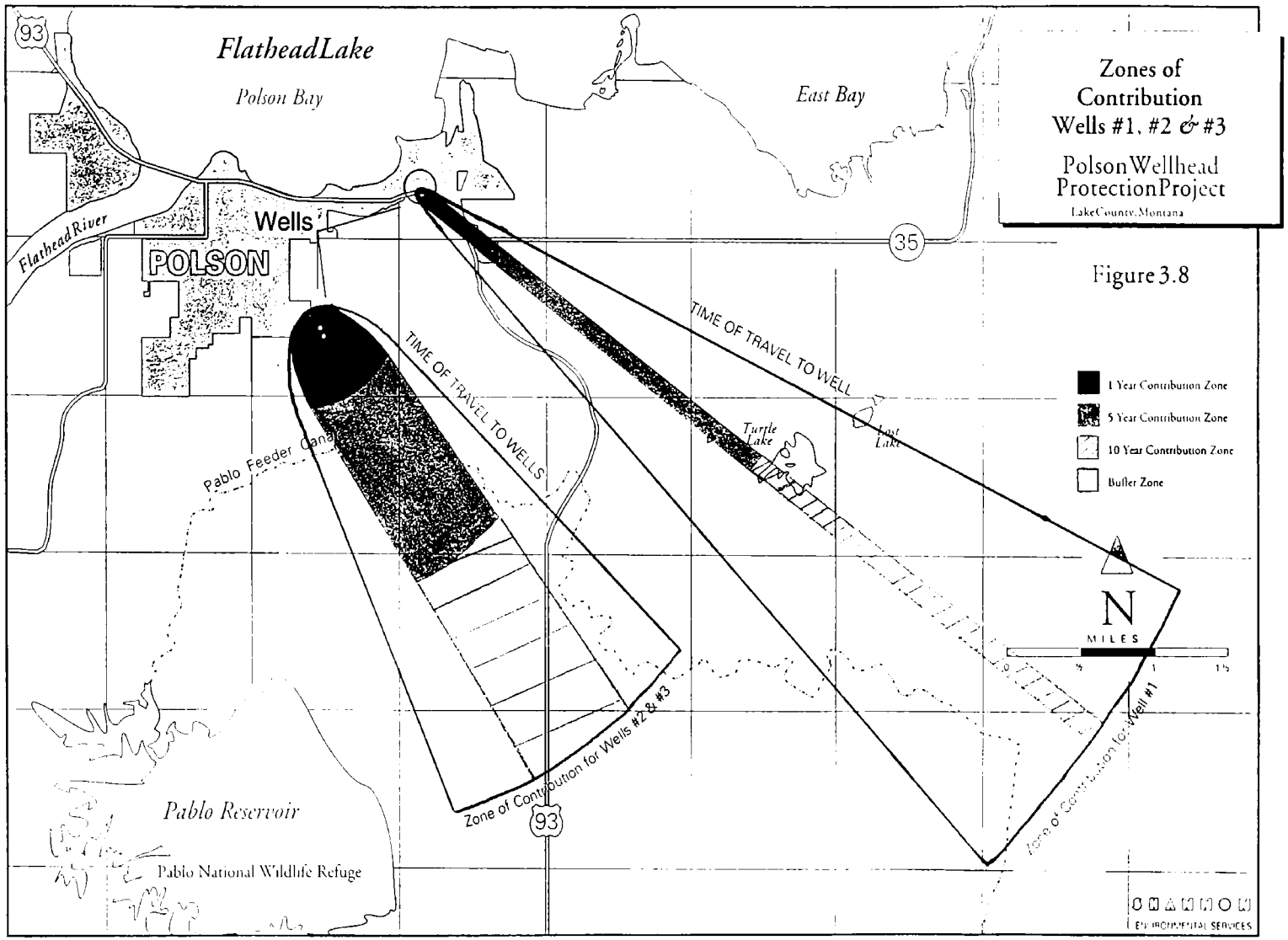

Figure 3 Polson Zones of Contribution
Source: Shannon Environmental Services

into 3 zones that were based on time of travel boundaries that roughly coincided with the distance groundwater would travel in one year, five years and ten years. Wells #2 and #3 share a common Zone I wellhead protection area while Well #1 is in another. All three wells are in the same Zone II WHPA and Zone III WHPA (Shannon Environmental Services, 1994.) The protection levels of the three zones vary. Zone I, located closest to the wells is the most protective zone; Zone II is the next most protected zone; and Zone III, located furthest from the wells is the least protected zone. Figure 4 shows the Polson WHPA. The southern and eastern boundaries of the Zone II WHPA also coincide with the City-County Planning Area boundary, a political boundary. Roads and section lines were used as boundaries for the Zone I's and Zone III. The PWHP Plan used the common practice of adopting wellhead protection area boundaries based upon political boundaries near the boundaries of the scientifically delineated zone of contribution. This is done because it would be difficult to implement management programs using wellhead protection boundaries that would not be easily identified. The PWHP Plan's wellhead protection area encompasses more land, and is therefore more protective than the scientifically delineated zones of contribution. Some of this land may not contribute recharge to the public water supply wells. This situation represents a tradeoff commonly encountered in wellhead protection.

The Polson Wellhead Protection Area (PWHPA) lies entirely within the Flathead Indian Reservation, with Zones I and II of the WHPA lying within the City-County Planning Area. The PWHPA covers a fairly large contiguous area.

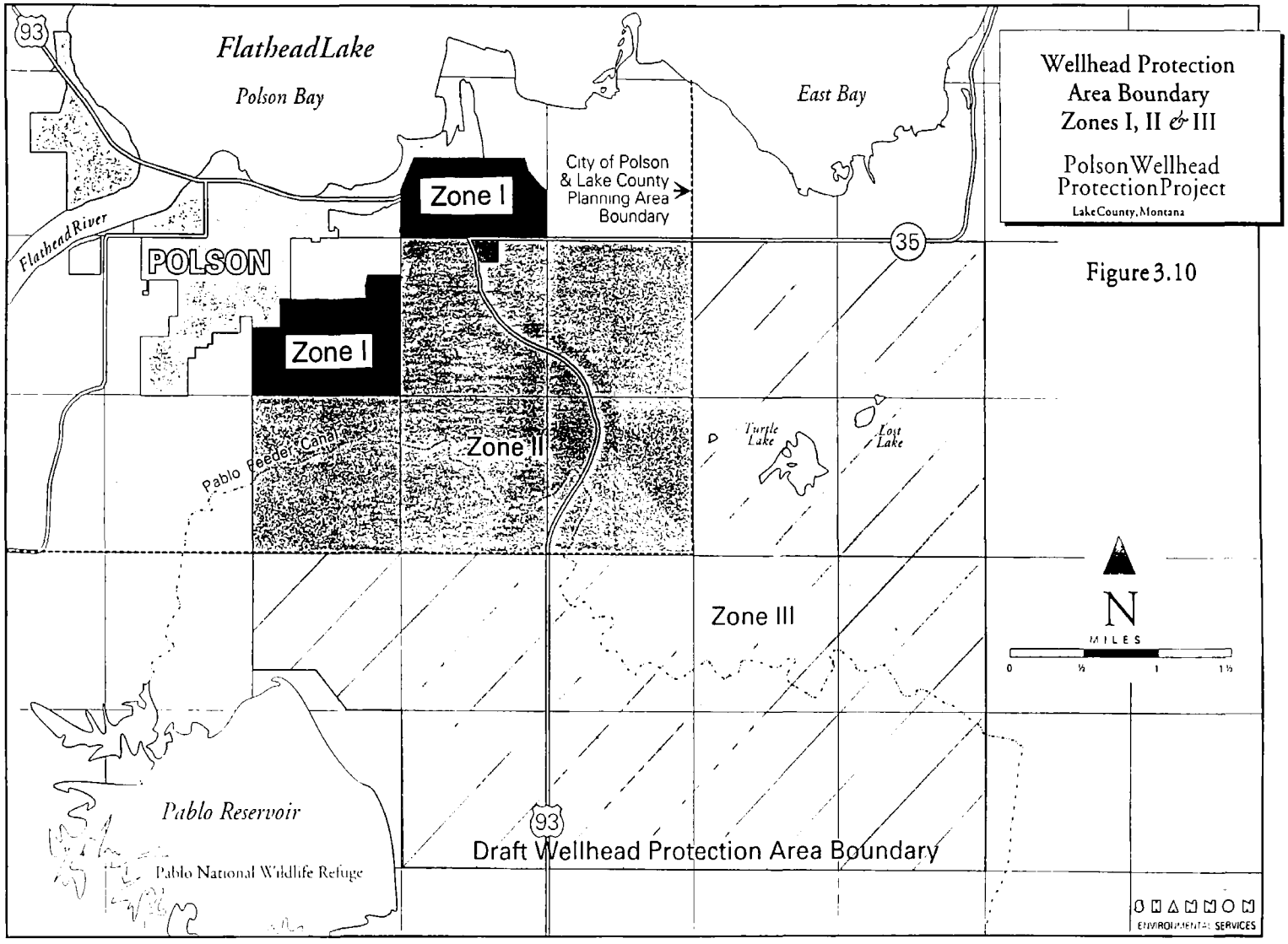

Figure 4 Polson Wellhead Protection Area
Source: Shannon Environmental Services

3.3 Recommendations for Wellhead Protection Area Delineations

The delineation element can be the most expensive element. Depending on the quality of aquifer information, communities may need to hire a hydrogeologist, or other experienced groundwater professional to assist with the delineation of wellhead protection areas. Communities should inform the Montana Department of Health and Environmental Sciences that their community is developing a WHP plan. MDHES may know of special research grants that the community could apply for, and the Wellhead Protection Coordinator at MDHES may be able to assist communities with delineation. Communities may also contact universities to investigate the possibility of using hydrogeology graduate students to assist with delineation. The MDHES and Montana Bureau of Mines and Geology have groundwater reports and investigations specific to many areas of the state.

Communities should try to use the most sophisticated method possible, but avoid spending all of their resources on this element, or using a method that requires more data than is available or obtainable for a reasonable cost. Most computer models require a good understanding of aquifer parameters. Using inadequate data in a computer model can result in erroneous delineations. It is better to use less sophisticated methods of delineation than to try to use computer models with too little information.

It is acceptable to delineate "first cut" WHPAs that will be refined as more resources and information become available in later years. The first cut WHPAs may be more protective than refined WHPAs; however, the overprotectiveness

can be tempered with a zoned approach. The key is to delineate an area and begin to develop strategies for groundwater protection.

Missoula and Polson used computer modeling in different ways to assist in the delineation element. Missoula was able to depend completely on computer modeling because of the amount of information available about the aquifer. Polson used computer modeling to augment analytical calculations and hydrogeologic mapping. The computer model enabled a "sensitivity analysis" to be conducted on the Polson WHPAs. Different values for various parameters could be input into the computer to estimate how the zones of contribution would change under different conditions. This helped the Polson Advisory Group select final zones of contribution. The EPA WHPA Code was a valuable tool for Polson, even though limited information was available about the aquifer. Sensitivity analyses were conducted on the Missoula aquifer also.

Zoned approaches are recommended. Both Missoula and Polson used zoned approaches to differentiate areas that need more protection from areas that do not. Zones also help communities set priorities for wellhead protection.

In cases where seasonal and annual variations in aquifer parameters are unknown, or very variable, buffer areas are a method of protecting fringe areas of wellhead protection areas. Both Missoula and Polson used buffer areas to increase the size of the wellhead protection areas, and included areas that may or may not actually be in the zone of contribution. Buffer areas can also help when shifting from the scientifically delineated zone of contribution to the wellhead protection area delineation based on man-made or geographic

boundaries. Once Polson added buffer areas to the ZOCs, they were able to more easily select political boundaries for the WHPA.

A criticism of the Missoula WHP Plan is that no figures showing the final wellhead protection areas were included in the report. It was not possible to review the geographic size of the wellhead protection zones. It is also unclear how management methods can be implemented without delineated boundaries and maps.

The Missoula and Polson aquifers were unconfined and semi-confined systems, respectively. Both communities used methods of delineation that are best applied to unconfined aquifer systems. Communities that are dependent upon confined aquifer systems can use the same general approach for the delineation element, but will need to use different delineation methods. The EPA document entitled, "Wellhead Protection Strategies for Confined-Aquifer Settings," (EPA, 1991C) will be useful to communities dependent upon confined aquifer systems.

In most cases, wellhead protection areas must be delineated early in the project. The potential contamination source inventory and management strategy elements cannot be conducted until the WHPAs are delineated.

4.0 POTENTIAL CONTAMINATION SOURCE INVENTORY

The potential contamination source inventory phase of a wellhead protection program involves identifying potential sources of contamination and their actual occurrence in the WHPA. Generally, communities prepare a preliminary list of potential contamination sources. Members of the Advisory Group, Health Department, or other involved individuals then use maps with the delineated wellhead protection areas defined and the potential contamination source list to map potential sources of contamination in the field. Depending on the size of the WHPA, United States Geologic Survey topographic sheets, city maps, or Geocode maps may be used in the potential contamination source inventory. The Wellhead Protection coordinator at MDHES has prepared a very useful inventory form, which may be found in Appendix B.

Communities must then determine a method of prioritizing the potential sources of contamination because not all potential sources of contamination present the same threat to groundwater. Factors that influence the risk from potential sources include: the location of source relative to groundwater wells; the likelihood of a release from the potential source; and the expected severity of contamination. Some kinds of contaminants are more difficult to remove from an aquifer than others. For example, gasoline constituents are less dense than water and are generally located near the top of the aquifer, which make them easier to remove from the aquifer. Other contaminants, such as chlorinated solvents, are denser than water and tend to sink in the aquifer. They do not move through the aquifer in the same manner as water, which is one reason

they are difficult to remove from the aquifer.

4.1 The Missoula Wellhead Protection Plan

The contamination source inventory element of the Missoula Wellhead Protection Plan was prepared by the Missoula City-County Health Department. The MCCHD used EPA documents (listed in the reference section of this paper) to prepare their preliminary list of potential contamination sources. They also used *The Cape Cod Aquifer Management Project (CCAMP) Guide to Contamination Sources for Wellhead Protection* (Noake, 1988) to determine which land uses have the potential to contaminate groundwater. The MCCHD compiled aerial photos for the research area and contacted assorted regulatory agencies to prepare lists of specific potential contamination sources. the following information is available from state agencies upon request: 1) the Montana Underground Storage Tank Program--records of all registered underground storage tanks and reported leaking underground storage tanks; 2) the Montana Solid and Hazardous Waste Bureau--the Montana Comprehensive Environmental Clean-up and Responsibility (CECRA) list of non-National Priority List sites; and 3) the Montana Solid and Hazardous Waste Bureau--list of registered landfills and their classification. Files kept at the MCCHD concerning historic environmental contamination problems were also reviewed.

The MCCHD then conducted a street by street survey of potential contamination sources in a 22 square mile area surrounding Mountain Water Company's public drinking water wells (Hydrometrics, 1992.) It took employees

from MCCHD nearly four months to drive down each street in the wellhead protection area and map the land uses and potential threats associated with each use. Historic, as well as, existing uses were examined. A total of 414 potential sites were identified during the survey. Over 1,150 street and parking lot storm drains were added to an existing street storm drain inventory, for a total of 3,350 street and parking lot storm drains (Hydrometrics, 1992.)

As a result of the survey, the potential sources identified in the Missoula Wellhead Protection Area were prioritized from greatest perceived threat to least in the following order:

commercial injection wells
sewer lines and lift stations
septic systems
underground storage tanks (USTs) and pipelines
hazardous material generators
stormwater systems and stormwater sumps
landfills, lagoons, etc...
truck and rail transportation routes and terminals
pesticide application
miscellaneous sources (photo developers, labs, mortuaries, etc...)
irrigation ditches
water wells

Types of sources and routes to the aquifer were primary considerations during the prioritization process. Sources designed to dispose or transport wastes and subsurface routes pose the greatest threat to the aquifer (Hydrometrics, 1992.) The kind of contaminant and its properties can also be

an important factor. Contaminants that do not naturally degrade present more of a threat than those that easily degrade.

The Missoula aquifer has been tested for volatile organic chemical (VOC) contamination since 1988. During that time twenty-two VOCs have been detected in the aquifer (Hydrometrics, 1992.) Numerous VOCs, such as benzene, vinyl chloride and carbon tetrachloride are known or probable human carcinogens (EPA, 1990 A.) Other VOCs present non-carcinogenic health threats to humans (EPA, 1990 A.) The Missoula WHP Plan includes a section that lists the VOCs found in the Missoula aquifer, a description of the contaminant, the number of times it has been detected and its average concentration (Hydrometrics, 1992.) The Missoula WHP Plan also describes thirteen past episodes of aquifer contamination.

4.2 The Polson Wellhead Protection Plan

The Polson Wellhead Protection Advisory Group developed a similar list of potential sources of contamination. Sources of information used to compile the categories of potential sources included the Missoula Wellhead Protection Plan, EPA documents (listed in the reference section of this paper), the CCAMP document and state regulatory lists (Shannon Environmental Services, 1994.) Lake County Land Services and the Lake County Disaster Emergency Services Office were also contacted for information concerning historic environmental contamination problems. The categories of potential contamination sources developed for the Polson area included:

underground storage tanks
septic systems
underground injection wells
pesticide and fertilizer application
transportation routes
water wells
wastewater lines and lift stations
irrigation canals
sand and gravel operations
hazardous materials

In order to identify individual potential sources of contamination, the land located within the wellhead protection area was visually inspected. Employees from Lake County Land Services and the Polson Water Department visited each home or business within Zones I and II of the Polson WHPA and inventoried the property for the potential sources listed on the Montana Wellhead Protection Program inventory form. When possible, homeowners were interviewed to find out additional information concerning potential threats, such as approximate age of underground storage tanks. Potential sources of contamination were mapped in the field using Lake County Geocode Maps. Data from these field maps was entered onto a computer mapping/CAD program. In addition to potential sources located within the wellhead protection area, a list of large regulated sites (such as landfills) in the Polson area was developed to determine if they may impact the Polson WHPA. Fortunately, they were all located outside of the WHPA (Shannon Environmental Services,

1994.)

Potential sources of contamination in the Polson WHPA were not prioritized based on the potential source of contamination, but based upon which zone of the wellhead protection area they were located within. The rationale for this prioritization was that potential sources of contamination located in Zone I pose more of a threat to the public water supply wells than potential sources located in Zone II because the former would generally take less time to reach the wells. Zone III was included on project delineation maps but not inventoried. The Polson Advisory Group felt that Zone III should not be treated as an active wellhead protection area, but an area to be conscious of in terms of future growth and development. The principle uses of Zone III are currently agricultural. The Advisory Group decided that if commercial growth begins to occur in that area, they would consider treating it as an active part of the Polson Wellhead Protection Area.

There were far fewer potential sources of contamination in the Polson Wellhead Protection Area than in the Missoula Wellhead Protection Area. This is due in part to the smaller geographic size of the Polson WHPA, but mostly it was due to the level and kind of development of the communities. Polson is far less developed industrially and commercially than Missoula. The most numerous potential contamination sources within the Polson Zones I and II were 166 private septic systems and 21 underground storage tanks.

4.3 Recommendations for Potential Contamination Source Inventories

The Missoula and Polson potential contamination source inventory approaches were similar. This is likely because Missoula conducted the first contamination source inventory in the state and did a thorough job. Polson based their approach to this element on Missoula's work. Other communities should find both the Missoula and Polson descriptions of the potential source inventories helpful.

City-County Health Departments and local water suppliers are frequently the best group to conduct the source inventories because they generally live in the community, are usually already involved in the development of the WHP plan, and are often knowledgeable about potential sources of contamination. Communities in other states have also used assorted community groups to assist with and/or conduct the source inventories. A few examples of those groups include the League of Women Voters, civic groups and senior citizens. Senior citizens are often knowledgeable about previous land uses and may know of historic potential sources of contamination. Even if a senior citizen's group is not assisting with the potential source inventory, it can be helpful to contact some older residents and ask them questions about historic land uses in the community. The Montana Wellhead Protection Program advocates the involvement of older citizens and other groups in the inventory process. Information concerning training of these kinds of volunteers may be available from the state in the future. Understanding the cause and effect of past

contamination events can help in identifying and preventing future contamination problems.

Public eduction can be an important aspect of the potential contamination source inventory element. Those conducting a door to door inventory and interviewing residents can explain the goals and activities of the wellhead protection plan. It is also an opportunity to distribute public education information to residents. The Montana Extension Service, MDHES and communities in other states have prepared numerous brochures describing best management practices for septic system maintenance, groundwater protective methods of applying fertilizer and pesticides, regulations and recommended maintenance practices for underground storage tanks and many other groundwater protection oriented materials.

A door to door potential contamination source inventory can become difficult when residents are not at home or are not welcoming. Methods to increase community awareness about the wellhead protection project and the potential contamination source inventory include publishing an article in a local newspaper with dates and neighborhoods that will be inventoried, or discussing the project on a local radio show. Including information in water bills is another method of informing citizens. Sometimes residents may not be willing to cooperate with the wellhead protection process. Explaining the wellhead protection project goals and methods may help increase their participation, or it may not.

The need to prioritize potential contamination sources will vary from

community to community depending on the number and kinds of potential sources identified. The Missoula WHP Plan prioritized potential sources within wellhead protection areas because of the large numbers of potential threats. The Polson WHP Plan prioritized the wellhead protection areas, and did not prioritize potential threats within the WHPAs.

The Montana Wellhead Protection Plan recommends that communities submit their WHPA potential contamination source inventory forms and maps to the MDHES. The Montana Program also recommends that communities update the potential contamination source inventories every two years and submit additions or changes to the MDHES (MDHES, 1992.)

5.0 MANAGEMENT ALTERNATIVES

The issue of management of potential sources of contamination within wellhead protection areas is crucial to the success of a wellhead protection plan. The management alternatives developed and implemented in each wellhead protection area will likely be different because they are based on the potential contamination sources identified in that area. Communities have numerous choices of management alternatives ranging from continuing with the status quo, to developing education programs and best management practices, to creating new stringent regulations.

5.1 The Missoula Wellhead Protection Plan

The Missoula WHP Plan was the first wellhead protection plan in Montana and as such created the first summary of groundwater protection laws and regulations. This summary includes federal, state and local laws. The work included in the Missoula WHP Plan is far too lengthy to include here, but offers an excellent framework for other communities to work from. A team consisting of MCCHD employees, Hydrometrics employees and a University of Montana law professor developed a list of wellhead protection area management options, or "tools", for potential use in the Missoula WHPA. These tools were compiled from literature from the EPA and examples of other wellhead protection plans in other states. This list described the management options, the benefits/disadvantages of each and the legal authority to implement them. The list includes: municipal ordinances, zoning ordinances, design standards, source prohibitions, groundwater monitoring, best management practices, local

water quality protection districts, subdivision regulations, site plan review, operating standards, purchase of property or development rights, public education, transaction induced investigations and capital improvement programs (Hydrometrics, 1992.) The Missoula WHP Plan also identified the following existing regulatory authority available to the city and county: groundwater user regulations; general source controls; specific source controls; land use controls; and inspection, containment and cleanup requirements.

After a lengthy review of the management options, potential sources of contamination, and regulatory authority, the management alternative team selected four tools for implementation immediately. The selected management options focus on regulating existing and new activities associated with the materials and substances that pose a threat to the aquifer because the MWC wells are located in an urban area (Hydrometrics, 1992.) The four management options include: 1) a municipal wellhead protection ordinance, 2) capital (infrastructure) improvements, 3) operating standards for transportation systems, and 4) public education.

The municipal wellhead protection ordinance (WHPO) would regulate the handling, storage, use, production and disposal of substances which have the potential to contaminate the aquifer (Hydrometrics, 1992.) Facilities that use regulated substances in Zones 1 and 2 would be required to: pay a fee to obtain a permit to use regulated substances in the Missoula area; inventory those substances; prepare a management plan describing how they are used, stored, handled, produced and disposed; and prepare a plan describing

procedures for cleaning up spills and releases at the facility. Appendix C includes a copy of the Missoula Wellhead Protection Ordinance Regulated Substance List with Threshold Quantities. New underground storage tanks would be required to install double containment structures on all tanks (Hydrometrics, 1992.) New facilities in the Zone 1 of WHPAs would be prohibited from using regulated substances. Existing activities would be permitted as legal noncomplying uses. Facilities that use regulated substances in Zone 3 would be required to submit an inventory in order to obtain a permit. The municipal WHPO would cover areas outside of the city limits through the mayor's extraterritorial powers (Hydrometrics, 1992.)

The second management option, infrastructure improvements, focuses on wastewater, stormwater and well design and also proposes changes in local policies concerning sewer and stormwater. The City of Missoula is amending the municipal codes to expand the industrial pre-treatment standards, further limit the disposal of certain substances into the wastewater collection system, and increase inspections of permitted facilities (Hydrometrics, 1992.) The third recommended change involves the bulk transportation of hazardous substances into and through the Missoula Valley. The Yellowstone Pipeline, located along the northern edge of the Missoula Valley, has experienced major leaks that have contaminated wells in the Grant Creek and LaValle Creek area (Hydrometrics, 1992.) Conoco, owner of the pipeline, has increased monitoring of the pipeline and added cathodic protection to the pipeline. The Missoula WHP Plan recommends that the results of Conoco's inspections be provided to

the administering agency for WHP in Missoula and that Conoco work cooperatively with the agency to protect the aquifer. The Missoula City/County Hazardous Material Plan has already designated routes for trucks carrying extremely hazardous substances; however, the Missoula WHP Plan recommended that these routes be redirected to avoid travelling through a Zone 1 of a WHPA (Hydrometrics, 1992.)

Public education, the fourth management option, is incorporated into the other three options, as well as being an option of its own. MWC has implemented an extensive groundwater public education campaign over the past several years. Information explaining the physical properties of the aquifer, its vulnerability to contamination and methods to prevent its contamination has been presented to the Missoula community via billboards, radio announcements, newspaper articles and advertisements, information in water bills, and presentations to the public and school children. During development of the Missoula WHP Plan, the MCCHD worked with conservation groups to get warnings stenciled on many of the street and parking lot drains cautioning people not to use the drains for waste disposal.

Missoula has already started implementing portions of the Missoula WHP Plan. The Missoula Board of Commissioners, the City of Missoula and the Missoula City-County Health Department proposed the "Missoula Valley Water Quality District" in 1992. The district, approved by the Missoula County Commissioners in early 1993, provides the county with a mechanism to implement ground and surface water quality protection programs. The WHPO is

designed to complement the Missoula Valley Water Quality District. As of March 1994, the ordinance was undergoing review by a subcommittee of the Missoula Board of Health. It is anticipated that the WHPO will be implemented during the summer of 1994 (Arvid Hiller, personal communication, 1994.)

5.2 The Polson Wellhead Protection Plan

The Management Alternatives section of the Polson Wellhead Protection Plan described management options associated with each potential contamination source. The Polson WHP Plan emphasized the enforcement of existing local, state, tribal and federal regulations, increased public education, public involvement and voluntary best management practices. When appropriate, the Polson WHP Plan described new or additional management approaches. The Polson WHP Plan used this "tiered" approach to management, moving from existing approaches to increasingly protective approaches for each potential contamination source (Shannon Environmental Services, 1994.) The Polson WHP Plan recommended more stringent regulation of underground storage tanks, private septic systems and hazardous materials to try to prevent the threat of contamination to the drinking water wells. The Polson public water supply wells have not experienced any significant contamination incidents.

The City and County zoning regulations were undergoing substantial review and revision at the same time that the Polson WHP Plan was being developed. Prior to that review and revision neither the Polson nor Lake County zoning or subdivision regulations directly addressed groundwater

protection. The revised *Polson Master Plan-Draft*, 1993, incorporated the Zone I and Zone II Polson WHPAs as overlay districts. The accompanying *Polson Development Code-Draft*, 1993, explained the Wellhead Protection Overlay District and subsequent land uses and performance standards for the Overlay Districts. Gravel mines, floor drains, use of hazardous materials, on-site sewage disposal and underground storage tanks were prohibited within Polson' s two Zone I WHPAs. Floor drains and the use of hazardous materials were also prohibited in Zone II of the WHPA. On-site sewage disposal was permitted in Zone II, with a minimum lot size of four acres.

The Polson WHP Plan also recommended that the City of Polson continue the practice of extending the city sewer system to some of the newly developed and previously unsewered areas south of Well #2 and Well #3 (Shannon Environmental Services, 1994.) The option of connection to city sewer is available to those homeowners at a cost equivalent to that of installing a private septic system. Polson has found this approach to be very successful. The WHP Plan also recommended expanding the practice throughout Zones I and II of the WHPA, and extending municipal sewer service to those areas in which an individual septic system may pose a threat to existing and potential wellhead protection areas.

The tiered approach to management permits Polson and Lake County to review growth in the area and select additional management approaches should they be necessary in the future. The Polson Water Department and Lake County Land Services will take the lead in management of the Polson

Wellhead Protection Plan within the boundaries of the City-County Planning Area. The Confederated Salish and Kootenai Tribes dispute the authority of the City of Polson and Lake County to manage the groundwater resources on the reservation. A letter from Mickey Pablo, Chairman of the Confederated Salish and Kootenai Tribes, to Jon Shannon, President of Shannon Environmental Services, states that "neither Polson, Lake County nor the State may properly regulate Reservation waters ..." because "...all of the surface and ground water within the exterior boundaries of the Flathead Indian Reservation is subject to the jurisdictional authority of the Tribes" (Pablo letter, 1993.) Because the issue of legal authority to manage resources on the Reservation was beyond the scope of the Polson WHP Plan, these concerns were not resolved in the Plan.

5.3 Recommendations for Management Alternatives

The individual approaches that communities take for managing existing and potential sources of contamination will depend upon the density and kinds of sources identified during their inventory. However, most communities will find the management alternatives chapters of the Missoula WHP Plan and the Polson WHP Plan very useful. Both the Missoula WHP Plan and the Polson WHP Plan benefitted from the input of different entities involved in their advisory groups, especially city and county input. The development and implementation of management alternatives in the Missoula WHPA took much longer because of the larger geographic area, greater number of potential contamination sources and wider range of involved organizations. Missoula is a large Montana city and any program impacting land use will undergo substantial

review and modification. The management approaches developed and implemented in association with the Polson WHP Plan were subjected to a review and revision phase, however, it was a faster process due to the smaller size of the Polson and Lake County administrations. Communities should be aware that implementing wellhead protection management alternatives can take months, and even years and that wellhead protection area management continues beyond the initial implementation of protective programs. Groundwater protection plans must be reviewed and revised on a regular basis.

The Missoula and Polson wellhead protection plans demonstrate another point that communities should be aware of as they investigate management approaches. Larger communities with more industrial activities near public wells, like Missoula, generally adopt management methods that emphasize the reduction of the threat of contamination from existing sources. While communities like Polson, with few commercial and industrial businesses located in the wellhead protection area, can emphasize controlling land uses and prevent the siting of potentially threatening uses in the vicinity of public wells.

Groundwater monitoring was not explicitly mentioned in either the Missoula or the Polson WHP Plans, however, it is an important management tool used by both communities. The Missoula and Polson public water supply systems are subject to sampling and monitoring requirements established by the Safe Drinking Water Act of 1974, and subsequent amendments. The EPA requires public water systems to regularly sample for volatile organic chemicals,

inorganic chemicals, organic chemicals, microorganisms and radionuclides. Different potential contaminants are sampled on different schedules. For example, Mountain Water Company sends 15-20 samples to an EPA approved laboratory each quarter for volatile organic chemical analysis. Inorganic chemicals present less of a threat and sampling is required only every three years (Bob Ward, personal communication, 1994.) Total coliform is tested for much more frequently, depending upon the population served.

Mountain Water Company tests for several potential contaminants not yet required by the EPA (Bob Ward, personal communication, 1994.) Of the 60 volatile organic chemicals that Mountain Water Company tests for, only 21 are regulated by the EPA. As mentioned previously, Mountain Water Company has taken two wells off-line due to contamination problems. The City of Polson generally limits its sample collection and analysis to the regulated contaminants (John Campbell, personal communication, 1993.) Aside from the *Giardia lamblia* contamination incident, Polson has not experienced a drinking water contamination problem.

6.0 NEW WELLS

The new well element of a wellhead protection plan requires communities to select locations for potential new wells. Wellhead protection areas are then delineated for each new well. Many state wellhead protection plans (including Montana's) recommend using an unsophisticated, quick delineation approach such as fixed radius circles for the new wellhead protection areas, since actual locations are not certain. In the Montana Draft Wellhead Protection Program (1992) the state recommended a fixed circle with a radius of 2,500 feet for delineation of new well wellhead protection areas. Once new WHPAs are delineated, the potential contamination source inventory and management strategy elements can be implemented.

Conducting the delineation and contamination source inventory on potential new well locations allows water purveyors to determine possible threats to future wells prior to their construction. If significant potential contamination sources are identified, an alternative site can be selected.

Oftentimes communities are reluctant to identify potential new well locations because the water purveyor does not own or control the potential new site (John Campbell, personal communication, 1993.) Publicizing potential new well locations in a wellhead protection plan may hinder or terminate the potential site acquisition process.

6.1 The Missoula Wellhead Protection Plan

Hydrometrics and Mountain Water Company identified several potential new well locations prior to the preparation of the Missoula WHP Plan. Site

locations for the new wells were limited due to the amount of development and related threat from contamination in the Missoula area. The most suitable area for new well development was located near the University of Montana campus (Hydrometrics, 1992.) When questioned about acquisition negotiations with the property owners, Arvid Hiller, General Manager for MWC, Missoula, reported that MWC was fortunate because the property went on sale shortly after the Hydrometrics' study. MWC was able to purchase the property for the appraised value (Arvid Hiller, personal communication, 1994.) Mr. Hiller also explained that because of the large size of MWC, the cost of land acquisition for new well locations is generally not a major concern. A wellhead protection area delineation was conducted for the future well site, which was designated a Zone 1 area. (Hydrometrics, 1992.)

6.2 The Polson Wellhead Protection Plan

Expansion of the City of Polson's water system is not limited as much by commercial and industrial growth, as it is by lack of known developable water resources. The City of Polson will likely need additional water supply from public wells in the future (Shannon Environmental Services, 1994.) The Polson Water Department has begun to assess the needs of the water system, but has not yet determined specific locations for new well sites. Two potential new well sites were identified in the Polson WHP Plan. The Plan called the sites theoretical potential sites. Polson used the Draft Montana WHP Program's recommendation of 2,500 foot radius circles to delineate WHPAs for the potential new wells. It is likely that these selected potential sites will change as

the Water Department determines the City's future needs (John Campbell, personal communication, 1993.)

6.3 Recommendations for New Wells

The issue of identifying potential new well sites on property that the water purveyor does not own or control will continue to be a difficult problem. Water purveyors feel that they are "tipping their hand" when they identify potential new well locations. In water scarce areas current property owners, or others, may feel that the selected property has more value once identified as a potential new well location because it will likely produce water and the price of the property may increase.

Communities are advised to use the state's recommended 2,500 foot circles for delineation, unless the future wellhead protection areas are more than theoretical. In that instance, the water purveyor should take the approach that Mountain Water Company used and delineate more sophisticated wellhead protection areas.

7.0 CONTINGENCY PLANNING

Contingency planning is a very important element for all wellhead protection plans. Periodic disruptions in water supply service may occur even with a wellhead protection plan in place. These disruptions may be a result of accidents releasing contaminants to the subsurface, power outages, discovery of existing contamination not before identified, or natural disasters (EPA, 1990 B.)

A water supply system contingency plan identifies potential threats to the water supply system and describes procedures to follow if an incident should occur which would render the wells unusable (EPA, 1990 B.) The plan should also include coordination procedures for local and state officials who would respond to an emergency situation and identify the necessary technical and financial resources to remedy the situation. The most important aspect of a contingency plan is identifying short term and permanent replacement water sources.

Several federal laws require the development of contingency plans that would ensure a safe drinking water supply in the event of an emergency or contamination of the public supply. Both the 1974 Safe Drinking Water Act (SDWA), the 1986 amendments to the SDWA, and the 1986 Superfund Amendments and Reauthorization Act (SARA) contain provisions for the development of water supply contingency plans (Shannon Environmental Services, 1994.)

7.1 The Missoula Wellhead Protection Plan

The Missoula WHP Plan contains a short description of how Mountain Water Company would supply the required water if a contamination event affected their well(s). Mountain Water Company relies upon 31 production wells to supply the needed 20 to 25 million gallons per day (MGD) of water to their customers. If necessary, the five top producing wells would be capable of supplying the 20-25 MGD required (Hydrometrics, 1992.) If one of these five wells were to be taken off line, the remaining smaller wells could supply the necessary water. A larger contamination event may require MWC to use surface water. If Rattlesnake Creek were to be used as a short term replacement, a boil order would have to accompany its use (Hydrometrics, 1992.)

In order to complete the certification requirements under the Draft Montana Wellhead Protection Program, more information about the Missoula WHP Plan contingency planning element must be presented to MDHES (Carole Mackin, personal communication, 1994.)

7.2 The Polson Wellhead Protection Plan

The contingency planning element of the Polson WHP describes a step by step process that communities can use to develop contingency plans. The outline for the Polson WHP plan was based on the EPA document, *Guide to Ground-water Supply Contingency Planning for Local and State Governments*, 1990. The steps include identifying potential threats to the water supply system, developing procedures to follow if a contamination incident occurs, and

identifying short term and permanent replacement water sources. The Polson WHP Plan also includes a listing of suggested members for the contingency team, as well as discussions concerning technical and financial resources to remedy the situation.

One weakness of the Polson WHP Plan is that it outlines how a community should approach the contingency planning element, but it does not actually address the needs of the Polson system specifically. This is because the goal of the Polson WHP Plan was to prepare the best possible outline and then have the Polson Water Department develop a Polson specific contingency plan from the outline. The City Water Department had not completed the Polson specific contingency plan as of March, 1994.

The Polson WHP Plan contingency element is in the same situation as the Missoula WHP Plan. The MDHES has informed the Polson Water Department that more information concerning the Polson contingency plan is required (Carole Mackin, personal communication, 1994.)

7.3 Recommendations for Contingency Planning

The Polson outline offers a very complete guideline for water purveyors to use as they prepare contingency plans. Should communities need more information, the EPA document *Guide to Ground-water Supply Contingency Planning for Local and State Governments*, 1990 explains contingency planing in great detail and includes several examples.

Neither the Missoula nor Polson contingency planning elements directly addressed emergency response and clean up of contamination events. It is

recommended that water purveyors work closely with engineering and environmental companies to establish plans for emergency response, short and long term water supply, and long term remediation. It is in the water purveyor's best interest to inform engineering and environmental companies about their system operations and establish working relationships prior to water supply emergencies.

8.0 PUBLIC EDUCATION

Public participation is critical to the successful implementation of a wellhead protection plan. The philosophy behind the Wellhead Protection Program and the goals of the Program are to educate citizens about their groundwater drinking water sources and to encourage them to protect these resources. The Wellhead Protection Program was designed to be a flexible program that enables communities to develop plans that meet the needs unique to their water supply situation. The Program recognizes that communities are very different hydrogeologically and politically. Local water purveyors and involved citizens are the people best able to determine what level of protection suits their water supply. The Program also recognizes that regulatory plans created from within a community generally work better than those mandated by the federal or state government.

8.1 The Missoula Wellhead Protection Plan

The Missoula WHP Plan was developed by several different entities. Mountain Water Company, Hydrometrics, Inc. and the Missoula City-County Health Department all played key roles in the development of the Plan. Due to the participation of these organizations, several other groups, such as the Missoula Interagency Groundwater Task Force, the Missoula County Commissioners, the Missoula City Council, the University of Montana, and the Missoula Water Advisory Council became involved in the Plan. Several presentations concerning wellhead protection were given in the Missoula area during development of the Missoula WHP Plan. Public comments and

recommendations are included in the final draft of the plan (Hydrometrics, 1992.)

Public education has been an extremely important element of the Missoula Wellhead Protection Plan. As mentioned in Chapter 5.0, MWC has implemented an extensive groundwater public education campaign over the past several years. MWC has used billboards, radio announcements, newspaper articles and advertisements, and presentations to the public and school children to teach residents of the Missoula Valley the value and vulnerability of the groundwater resource that they live above (Hydrometrics, 1992.)

Once the Wellhead Protection Ordinance is approved, the final Wellhead Protection Plan and recommended management approaches will be submitted to the Missoula City Council, the Mayor, and the Missoula County Commissioners and made available to the general public (Hydrometrics, 1992.)

8.2 The Polson Wellhead Protection Plan

The Polson WHP Plan was developed by Lake County Land Services, Polson Water Department, and Shannon Environmental Services. Public involvement was an important consideration throughout the preparation of the PWHP Plan. An Advisory Group consisting of representatives from the: Lake County Land Services, Polson Water Department, Lake County Commissioners, Polson City Council, Confederated Salish and Kootenai Tribes, Montana Department of Health and Environmental Sciences, Montana

Department of Natural Resources and general public was formed at the beginning of the project to offer input and guide the development of the Polson WHP Plan. The Advisory Group met every 6-8 weeks to review the progress of the Plan and to make recommendations on upcoming steps.

The Polson Wellhead Protection Advisory Group was a volunteer group, and anyone interested in participating in the Group was welcomed. Articles describing the Polson Wellhead Protection Project and announcing the formation of the Advisory Group appeared in the local paper prior to initiation of the project. Letters were also sent to several organizations inviting their participation in the Advisory Group.

Additional articles describing the project were published during the development of the WHP Plan. The potential contamination source inventory also offered an opportunity for area residents to learn about the groundwater resources that Polson depends upon and the wellhead protection plan.

A public meeting was held near the end of the development of the PWHP Plan to unveil the Plan and to solicit public comments. Draft copies of the Plan were sent out to several agencies and made available to the public. A six week comment period followed the public meeting. A few comment letters concerning the Plan were received. The comments were reviewed and incorporated into the final report. Response letters were also sent to each comment letter's author.

Copies of the final Wellhead Protection Plan were distributed to involved organizations. Presentations were made to the Polson City Council and Lake

County Commissioners at the conclusion of the project.

8.3 Recommendations for Public Education

Public involvement is critical to the development and successful implementation of a wellhead protection plan. Wellhead protection plans often include land use management elements that can be very controversial. In order to quell the controversy at an early stage, it is a good idea to form an advisory group familiar with the community and the community's groundwater protection goals to guide development of the project. Press releases are an effective way of letting local newspapers and radio stations know about the wellhead protection project. Once the WHPAs have been delineated and the potential contamination source conducted, information specific to the WHPA can be issued via newspaper articles, water bills, public meetings, etc... Mountain Water Company conducted an exemplary public education campaign. Communities interested in developing a wellhead protection public education program should contact Arvid Hiller at Mountain Water Company for copies of Mountain Water Company's materials.

One method of raising public awareness about groundwater quality not employed by Mountain Water Company would be publishing the results of monthly and quarterly water quality reports in the local newspaper. An accompanying narrative could explain what the results mean and report on drinking water quality trends.

9.0 CONCLUSIONS AND RECOMMENDATIONS

The Missoula and Polson wellhead protection plans are good model plans for other communities in Montana. Both plans thoroughly covered each of the recommended elements, except contingency planning. The Missoula and Polson approaches to dividing up responsibilities, conducting the WHPA delineation, developing management approaches and selecting new well locations were very different and reflect the uniqueness of the communities. It is likely that any other community using the Missoula and/or Polson WHP plans as a guide will also develop a slightly different WHP plan. Table 1 shows the different wellhead protection elements and a few comments related to each element as described in previous chapters.

One of the goals of WHP is to have flexible federal and state programs, so that communities can develop plans that are suited to their particular situation. Communities are also encouraged to contact the Montana Department of Health and Environmental Sciences (MDHES) and EPA for further information pertaining to WHP.

Funding will continue to be a difficult issue for communities wishing to develop wellhead protection plans. As mentioned previously, much of the preparation of the WHP plan can be conducted by local government employees or other entities. Assistance from a groundwater professional may be required during the delineation element. If communities want to investigate the potential for outside funding for the development of WHP plans they should contact the WHP Coordinator at MDHES.

Table 1 Wellhead Protection Plan Elements and Recommendations

WHP Element	Recommendations
Roles and Responsibilities	* Establish clear roles and responsibilities in the beginning of the project. * Form a multi-interest citizen/government advisory group. Target key people-water department superintendent, planner, city council members and members of the public. * Obtain the support of the water purveyor. * Secure funding prior to project initiation.
WHPA Delineation	* Assess existing hydrogeologic information and determine how difficult/expensive additional information would be to collect. * Determine sophistication of delineation desired. * Delineate zones within the WHPAs and add buffer zones to account for hydrogeologic variation and error in delineation.
Potential Contamination Source Inventory	* Select list of potential sources of contamination. * Select method of inventory. * Select individuals/groups to conduct the inventory. * Prioritize potential contamination sources.
Management Alternatives	* Review the potential contamination source inventory and decide on appropriate management methods. * Discussions with local governments and potentially impacted parties may modify selected approaches.
New Wells	* Select sites for potential new wells and use the Montana Wellhead Protection Program's recommended delineation method.
Contingency Planning	* Review the existing water department contingency plan and the county Disaster Emergency Service contingency plan to determine where improvements can be made.
Public Participation	* Hold a public meeting very early in the project to explain about the WHP project and to invite members of the public to participate on the WHP Advisory Group * Prepare press releases informing the public about the initiation and progress of the WHP plan. * Hold public meetings at the beginning and end of the WHP project.

Generally, grant programs to support the development of WHP plans are rare. However, they sometimes do become available. The Polson WHP

Plan was prepared using funds from the Department of Natural Resources and Conservation Renewable Resources Grant and the City of Choteau, Montana is preparing a WHP plan using EPA Wellhead Protection Demonstration Project Grant monies.

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APPENDIX A:
List of Organizations Involved with the Missoula and Polson Wellhead Protection Plans

Hydrometrics, Incorporated
2727 Airport Road
Helena, Montana 59601
406-443-4150

Lake County Land Services
106 Fourth Avenue East
Polson, Montana 59860
406-883-7235

Missoula Valley Water Quality District
Missoula City County Health Department
301 West Alder Street
Missoula, Montana 59802
406-523-4890

Montana Department of Health and Environmental Services
Wellhead Protection Coordinator
Water Quality Bureau
Cogswell Building, Room A206
Helena, Montana 59620
406-444-2406

Mountain Water Company
1345 West Broadway
Missoula, Montana 59802
406-721-5570

Polson Water Department
112 First Street East
Polson, Montana 59860
406-883-2131

Shannon Environmental Services
1151 West Broadway
Missoula, Montana 59802
406-543-4210

United States Environmental Protection Agency
Office of Ground Water, Water Management Division
Region VIII
999 18th Street
Denver, Colorado 80202-2405
303-293-1796

APPENDIX B:
Montana Department of Health and Environmental Sciences
Potential Contamination Source Inventory Form

Source Number ____
Public Water Supply Well ____
Inventory Person ____
See Attached Map No. ____

SUGGESTED INVENTORY FORM

A. Occupants Name: _____
B. Site Address: _____
C. City: _____ Zip Code: _____
D. County: _____ T/R/S: _____
E. Phone Number: _____ Lat/Long: _____
Name, Address, and Phone Number of Property Owner if Different From Above: _____
_____
_____

Nature of Property

Residential	_____	Commercial	_____	Agricultural	_____
Industrial	_____	City Govt Site	_____	Other ( )	_____

Potential Sources of Contamination

Circle the potential sources listed below that you have identified at this site. In the space provided, indicate how many.

POTENTIAL SOURCE	QUANTITY	POTENTIAL SOURCE	QUANTITY
Abandoned Water Well	____	Holding Pond/Lagoon	____
Above Ground Storage Tank	____	Injection Well	____
Stormwater Sumps/Ponds	____	Pipelines	____
Animal Feedlot	____	Mine/Quarry	____
Artificial Recharge Projects	____	Municipal Sewage	____
Auto Salvage Yard	____	Oil/Gas Well	____
Irrigated Lawns & Crops	____	Brine Pits	____
Cesspool, Septic Tank, Privie	____	Railroad	____
Chemical Storage Facility	____	Service Station	
Drainage Well/Canal	____	Disposal Well	____
Dump or Landfill	____	Sewage Plant Sludge	
Fertilizer/Pesticide Use	____	Disposal	____
& Mixing/Loading Site	____	Stream (Lake, River, Creek)	____
Land Farm	____	Underground Storage Tank	____
Grain Storage Bin	____	Chemigation Well	____
Highway or Road Frontage	____	Water Well	____
		Other	____

Chemicals Used Or Stored: _____
_____

APPENDIX C:
Regulated Substances List with Threshold Quantities

REGULATED SUBSTANCE THRESHOLD QUANTITIES

MISSOULA AQUIFER PROTECTION ORDINANCE REGULATED SUBSTANCE THRESHOLD QUANTITIES					
Compound or Substance	Physical State [1]	Synonyn	Use	CASRN	Threshold Quantity (lbs.) [2]
Acenaphthene	solid	1,2-Dihydroacenapthylene	dyes, insectidices, plastics	83-32-9	100
Acetone	liquid	2-Propanone, Pyroacetic acid	solvent, sealants, adhesives	67-64-1	5000
Acrolein	liquid	2-Propenal, Allyl aldehyde, Biocide	herbicide, refrigerant, plastics	107-02-8	1
Acrylamide	liquid	2-propenamide	polymer	79-06-01	1000
Acrylonitrile	liquid	Acritet, Acrylon, 2-propenitrile	wood pulp polymer, dyes, surfactants	107-13-1	100
Alachlor	liquid	N-Methoxymethyl acetamide	herbicide	15972-60-8	1
Aldicarb	liquid	Temik, 2-Methyl-2-(Methio) propenal	insecticide	116-06-3	1
Aldrin	solid	Aldrec, Aldrex, Aldosol	insecticide	309-00-2	1
Anthracene	solid	Anthrcin, green oil	dyes, insecticide, wood preservative	120-12-7	5000
Antimony	solid		metal coatings, metal alloys	7440-36-0	5000
Arsenic	solid		used to harden copper and lead, manufacturing of some glass	7440-38-2	1
Atrazine	liquid		herbicide	1912-24-9	1
Barium	solid		used in spectroscopy, electronic tubes	7440-39-3	5000
Benzene	liquid	Benzol, Coal naphtha, Mineral naphthalene	solvent, pesticides, resins, paint thinners, fuels	71-43-2	10
Benzidine	solid	1,1-Biphenyl-4,4-diamine	dyes, stains, laboratory reagent, rubber compounds	92-87-5	1
Benzo (a) Pyrene	soild	3,4-Benzopyrene	coal tar derivative, research chemical	50-32-8	1
Benzo (b) Fluoranthene	solid	Benz(e)acephenanthrylene	coal tar derivative, research chemical	205-99-2	1
Benzo (k) Fluoranthene	solid	11,12-Benzofluoranthene	coal tar derivative, research chemical	207-8-9	5000
Benz (a) Anthracene	solid	Benz(a)anthracene, Tetraphene	coal tar derivative, research chemical	56-55-3	10

MISSOULA AQUIFER PROTECTION ORDINANCE REGULATED SUBSTANCE THRESHOLD QUANTITIES

Compound or Substance	Physical State	Synonyn	Use	CASRN	Threshold Quantity (lbs.)
Beryllium	solid	Glucinium	copper alloys	7440-41-7	10
Beta-Chloronaphthalene	liquid	2-Chloronaphthalene	solvent	91-58-7	10
Bis (2-chloroethyl) Ether	liquid	Bis (chloroethyl) ether, Chlorex	cleaining solvent, dry cleaning	111-44-4	10
Bis (2-Chloroisopropyl) Ether	liquid	BCIE, 2,2-Oxybis(1-Chloropropane)	dyes, resins, solvent, wood preservative	39638-32-9	10
Bis (Chloromethyl) Ether	liquid		solvent	542-88-1	10
Bromodichloromethane	liquid	Dichlorobromomethane, BDCM	fire extinguishers, solvent lab chemical	75-27-4	5000
p-Bromodiphenyl Ether	liquid	4-Bromodiphenyl ether, p-Bromophenylphenyl Ether, 4-Bromophenyl Phenyl Ether	research chemical	101-55-3	100
Bromoform	liquid	Tribromomethane	solvent, fire retartant	75-25-2	100
n-Benzyl butyl phthalate	liquid	1,2-Benzenedicarboxylic acid	plasicizer in PVC, additivie to ethylene glycol	85-68-7	100
Cadmium	solid		electroplating, process engraving	7440-43-9	10
Carbofuran	solid		insecticide	1563-66-2	10
Carbon Disulfide	liquid	Dithiocarbonic Anhydride	solvent, disinfectant	75-15-0	100
Carbon Tetrachloride	liquid	Tetrachloromethane	refrigerant, solvent	56-23-5	10
Chlordane	liquid	Chloridan, Chlor kil, Chlortox, Dowklor	insecticide	57-74-9	1
p-Chloro-m-Cresol	soild	4-Chloro-m-cresol, 4-Chloro-3-methylphenol	germacide, paints, inks	59-50-7	5000
Chlorobenzene	liquid	Monochlorobenzene	solvent, pesticide	108-90-7	100
Chloroform	liquid	Trichloromethane	refrigerant, solvent, insecticide	67-66-3	10
2-chlorophenol	liquid	o-Chlorophenol	disinfectant, resins, solvent	95-57-8	100
Chromium (VI)	solid		alloys, electroplating	18540-29-9	1
Chrysene	solid	1,2-Benzophenanthrene	coal tar derivative, organinc synthesis	218-01-09	100
Copper	solid		manufacturing bronze, brass, copper alloys	7440-50-8	5000
Cyanide	solid		electroplating	57-12-5	10
Creosote	liquid	wood creosote	wood preservative	8001-58-9	1
Dalapon, sodium salt	liquid	2,2-Dichloropropionic Acid	herbicide	75-99-00	5000

MISSOULA AQUIFER PROTECTION ORDINANCE REGULATED SUBSTANCE THRESHOLD QUANTITIES					
Compound or Substance	Physical State	Synonyn	Use	CASRN	Threshold Quantity (lbs.)
Di (2-Ethylehexyl) Adipate	liquid	Hexanedioic Acid		103-23-1	100
Di (2-ethylhexyl) Phthalate	liquid	1,2-Benzenedicarboxylic Acid	Plasticizer in vacuum pumps	117-81-7	100
Dibenz (a,h) Anthracene	solid	Dibenzo (a,h) Anthracene, 1,2,5,6-Dibenzanthracene	research chemical	53-70-3	1
1,2-Dibromo-3-Chloropropane	liquid	(DBCP), Dibromochloropropane	fire extinguisher agent, insecticide, refrigerant	96-12-8	1
Dibromochloromethane	liquid	Chlorodibromomethane, CDBM	fire extinguisher agent, insecticide, refrigerant	124-48-1	100
Dibutyl Phthalate	liquid	Di-n-Butyl Phthalate	plasticizer, insect repellant	84-74-2	10
1,2-Dichlorobenzene	liquid	ortho-Dichlorobenzene	solvent, insecticide, disinfectant	95-50-1	100
1,3-Dichlorobenzene	liquid	meta-Dichlorobenzene	insecticide	541-73-1	100
1,4-Dichlorobenzene	solid	para-Dichlorobenzene	insecticide, disinfectant	106-46-7	100
3,3-Dichlorobenzidine	solid	3,3-Dichloro-1,1-(biphenyl)-4,4-diamine	polymer, resin, dyes, rubber, plastics	91-94-1	1
4,4-DDD	soild	p,p-Dichlorodiphenyl Dichloroethane	pesticide	72-54-8	1
4,4-DDE	solid	p,p-Dichlorodiphenyldichloroethene,	military product, chemical research	72-55-9	1
4,4-DDT	solid	p,p-Dichlorodiphenylethane	insecticide	50-29-3	1
1,2-Dichloroethane	liquid	Brocide, Borer sol, 1,2-Bichloroethane	solvent, soil fumigant	107-06-2	100
1,1-Dichloroethylene	liquid	Vinylidene Chloride	adhesives, resins	75-35-4	100
Cis-1,2-Dichloroethylene	liquid	Acetylene Dichloride	solvent	156-59-2	1000
Trans-1,2-Dichloroethylene	liquid	1,2-trans-Dichloroethylene	solvent	156-60-5	1000
Dichloromethane	liquid	Methylene Chloride	solvent	75-89-2	1000
2,4-Dichlorophenol	solid	3-Chloro-4-hydroxychlorobenzene	pesticide	120-83-2	100

MISSOULA AQUIFER PROTECTION ORDINANCE REGULATED SUBSTANCE THRESHOLD QUANTITIES

Compound or Substance	Physical State	Synonyms	Use	CASRN	Threshold Quantity (lbs.)
2,4-D	solid	2,4-Dichlorophenoxy Acetic Acid, Hedanol, Trinoxol	herbicide	94-75-7	100
1,2-Dichloropropane	liquid	Propylene Dichloride	solvent, soil fumigant	78-87-5	1000
1,3-Dichloropropene	liquid	Telone II, 1,3-Dichloropropylene	soil fumigant	542-75-6	100
Dieldrin	soild	Alvit, Dieldrix	insecticide, wood preservative	60-57-1	1
Diesel/Fuel Oil/Jet Fuel	liquid	Kerosene, Diesel #1, #2, Aviation Fuel	Petroleum fuel	na	250
Diethyl Phthalate	liquid	Anozol, diethyl ether	plasticizer, insecticide, dyes, solvent	84-66-2	1000
Dimethyl Phthalate	liquid	Avolin, dimethyl ester	plasticizer, resins, lacquers, rubber	131-11-3	5000
2,4-Dimethylphenol	soild	Xylenol	phenolic antioxidant, plastics, resins, solvent, disinfectant, lubricant, petroleum	105-67-9	100
4,6-Dinitro-o-Cresol	soild	4,6-Dinitro-2-Methylphenol	herbicide	534-52-1	10
2,4-Dinitrophenol	soild	Aldifen	photo agent, pesticide, wood preservative	51-28-5	10
2,4-Dinitrotoluene	liquid	1-methyl-2,4-dinitrobenzene	dyes, explosives	121-14-2	10
Dinoseb	liquid	2-(methylpropyl)-4,6-dinitrophenol	herbicide, insecticide	88-85-7	100
1,2-Diphenylhydrazine	solid	Bianiline	pharmacuetical drugs	122-66-7	10
Diquat	solid		herbicide	85-00-7	1000
Endosulfan	solid	Malix, Thiodan, Thiorex	insecticide	115-29-7	1
Endothall	solid	Endothal	herbicide	145-73-3	1000
Endrin	solid	mendrin, nendrin, hexadin	insecticide	72-20-8	1
Epichlorohydrin	liquid	Chloromethyloximane	solvent	106-89-8	100
Ethylbenzene	liquid		solvent, intermediate for Styrene	100-41-4	1000
1,2-Ethylene Dibromide	liquid	Ethylene Dibromide, (EDB)	product in gasoline, fumigant	106-93-4	1
Ethylene Glycol	liquid		antifreeze	107-21-1	1
Fluoranthene	solid		research chemical	206-44-0	100
Fluorene	solid	2,2-Methylenebiphenyl	resins, insecticide	86-73-7	5000
Formaldehyde Solution	liquid	Formalin, Formol, Morbicid	disinfectant, germicide, resins, dyes, water proofing, hide preservation, photography	50-00-0	100

MISSOULA AQUIFER PROTECTION ORDINANCE REGULATED SUBSTANCE THRESHOLD QUANTITIES

Compound or Substance	Physical State	Synonyms	use	CASRN	Threshold Quantity (lbs.)
Gasoline	liquid	Gasohol, Petro	fuel	na	250
Glyphosate	solid	Roundup	herbicide	1071-83-6	100
Guthion	solid	Azinphos-methyl	insecticide	86-50-0	1
Heptachlor	soild	Drinox, Heptamul, Velsicol	insecticide	76-44-8	1
Hexachlorobenzene	solid	Perchlobenzene, bunt-care	organic chemical synthesis, fungicide	118-74-1	10
Hexachlorobutadiene	liquid	Dolen-pur, HCBD	solvent, transformer oil, hydraulic fluid	87-68-3	1
Alpha-Hexachlorocyclohexane	solid	alpha-BHC, Hexachlorocyclohexane-alpha	insecticide	319-84-6	10
Beta-Hexachlorocyclohexane	solid	beta-BHC, Hexachlorocyclohexane-beta	insecticide	319-85-7	1
Gamma-Hexachlorocyclohexane	solid	Lindane, gamma-BHC, Hexachlorocyclohexane-gamma	insecticide	58-89-9	1
Delta-Hexachlorocyclohexane	solid	delta-BHC, Hexachlorocyclohexane-delta	insecticide	319-86-8	1
Hexachlorocyclopentadiene	liquid	HEX, Graphlox, HCCP	dyes, pesticides	77-47-4	10
Hexachloroethane	solid	Avlothane, Distokal, Distopan, Egitol	resins, plasticizer, solvent	67-72-1	100
Hydrochloric Acid	liquid	Muriatic Acid	hydrolyze starch and proteins, lab reagent, pickling and cleaning metals	7647-01-0	5000
Hydrofluoric Acid	liquid	Fluorohydric Acid	pickling andcleaning metals	7664-39-3	100
Hydrogen Peroxide >52% sln.	liquid	Hydrogen dioxide, Hooxyl	cleaning agent	7722-84-1	1000
Indeno (1,2,3-cd) Pyrene	solid	Indenopyren	coal tar derivative	193-39-5	100
Isophorone	liquid	Isoacetophorine, Isoforon	solvent, resins	78-59-1	5000
Lead	solid		maunfacture of sulfuric acid, petroleum, halogenated compds., paints; metallurgy	7439-92-1	1
Malathion	liquid	Cythion, Malama 50, Prioderm	insecticide	121-75-5	100
Mercury	solid	Liquid silver	slats, thermometers, barometers	7439-97-6	1
Methanol	liquid	Methyl Alcohol, carbinol	solvent	67-56-1	5000
Methoxychlor	solid	Chenform, Marlate	insecticide	72-43-5	1
Methyl Ethyl Ketone	liquid	2-Butanone	solvent	78-93-3	5000
Mirex	solid	Dechlorane	insecticide, fire retartent used in plastics, rubber, paints, and paper	2385-85-5	100

MISSOULA AQUIFER PROTECTION ORDINANCE REGULATED SUBSTANCE TIIRESHOLD QUANTITIES

Compound or Substance	Physical State	Synonyms	Use	CASRN	Threshold Quantity (lbs.)
Naphthalene	solid	Camphor tar, Naphthalin	pesticides, dyes, resins, detergents	91-20-3	100
New Oil	liquid	all types of oils	lubricants	na	250
Nickel	solid		plating of metal and wire	7440-02-0	100
Nitrobenzene	liquid	Mirbane Oil	solvent, shoe polish, photo agent	98-95-3	100
Nitric Acid	liquid	Aquafortis	manufacturing of fertilizers and dyes	7697-37-2	1000
N-Nitrosodi-n-Propylamine	liquid	Dipropylnitrosamine	research chemical	621-64-7	10
N-Nitrosodimethylamine	liquid	DMN	solvent, lubricant, antioxidant	62-75-9	10
N-Nitrosodiphenylamine	solid	Benzenamine, Curetarol	rubber processing	86-30-6	100
N-Nitrosopyrrolidene	liquid	1-Nitrosopyrrolidine		930-55=2	1
Oxamyl	solid	Vydate, Thoxymal	insecticide	23135-22-0	1
Parathion	liquid	Alkron, Aphamite, Etilon, Niram,	insecticide	56-38-2	10
Potassium Hydroxide	solid		electroplating, inks, soaps, paint and varnish removers	1310-58-3	1000
Pentachlorobenzene	liquid			608-93-5	10
Pentachlorophenol	solid	Penta, PCP, Penchlorol	insecticide, wood preservative	87-86-5	10
Polychlorinated Biphenyls	liquid	Chlorodiphenyls	Dielectric liquids, transformr oils, rubber	1336-36-3	1
Phenanthrene	solid		coal tar derivative, biochemical research	85-01-8	5000
Phenol	liquid	Benzenol, Carbolic Acid	Antiseptic, disinfectant, dyes, oils, paints	108-95-2	1000
Picloram	solid	Tordon	herbicide	1918-02-1	10
Pyrene	solid	Benzo(d,e,f)phenanthrene	coal tar derivative, research chemical	129-00-0	5000
Selenium	solid		photography, glass, semiconductros, rubber	7782-49-2	100
Silver	solid		photo processing	7440-22-4	1000
Simazine	solid	Simanex, Primotal, Gesatop	herbicide	122-34-9	10
Sodium Hydroxide	solid	Caustic Soda, Soda Lye	neutralizer, salts, precipitant	1310-73-2	1000
Styrene	liquid	Cinnamene, Ethenyl Benzene	rubber, resins, protective coatings	100-42-5	1000
Sulfuric Acid	liquid	Oil of Vitriol	maunfacturing of fertilizer, pickling of metal	7664-93-9	1000
1,2,4,5-Tetrachlorobenzene				94-95-3	5000

MISSOULA AQUIFER PROTECTION ORDINANCE REGULATED SUBSTANCE THRESHOLD QUANTITIES					
Compound or Substance	Physical State	Synonyms	Use	CASRN	Threshold Quantity (lbs.)
1,1,2,2-Tetrachloroethane	liquid	Acetosol, Acetylene Tetrachloride	solvent, insecticide, herbicide	79-34-5	100
Tetrachloroethylene (PCE)	liquid	Dee-Solv, Perchlor	solvent, dry cleaning	127-18-4	100
Thallium	solid		rodenticide, alloys	7440-28-0	1000
Toluene	liquid	Methyl benzene	solvent	108-88-3	1000
Toxaphene	solid	Alltox, Geniphene, Motox, Phenatox	insecticide	8001-35-2	1
1,2,4-Trichlorobenzene	liquid		solvent, trasformer oils, lubiricants	120-82-1	100
1,1,1-Trichloroethane	liquid	Methylchloroform, Chlorothene	solvent	71-55-6	1000
1,1,2-Trichloroethane	liquid	Ethane Trichloride	solvent	79-00-5	100
Trichloroethylene (TCE)	liquid	Trichloroethene	solvent	79-01-6	100
2,4,5-Trichlorophenol	solid	Collunosol, Dowicide 2, Phenachlor	fungicide, batericide	95-95-4	10
2,4,6-Trichlorophenol	solid	Dowicide 2S, Omal	wood and glue preservative	88-06-2	10
2,4,5-TP	solid	2-(2,4,5-Trichlorophenoxy)-Proprionic Acid, Silvex	herbicide	93-72-1	100
Vinyl chloride	liquid	Chloroethylene	manfacturing of PVC, adhesives, refigerant, solvent	75-01-04	1
Waste Oil	liquid	used oil	waste product	na	250
Xylenes	liquid	octa, meta, and para forms	solvent, fuels, dyes, insecticide	1330-20-7	1000
Zinc	solid		alloys	7440-66-6	1000

Notes:

1) Physical State at time of manufacture.

2) Threshold Quantities: The threshold quantity shown above is the lowest reportable quantity or threshold planning quantity published in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 40 CFR Part 302, Table 302.4, or the Superfund Amendments and Reatuhorization Act (SARA) Section 302, Extremely Hazardous Substances, 40 CFR Part 355, Appendicies A and B.